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MATERIAL - SPECIAL 2024-T86 ALUMINUM - MECHANICAL AND CORROSIVE PROPERTIES - DETERMINATION OF

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TITLE

MATERIAL - SPECIAL 2024 T86 ALUMINUM -

MECHANICAL AND CORROSIVE PROPERTIES - DETERMINATION OF

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The tests described in this report were conducted between February and May 1957.

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REVISIONS

NO.	DATE	BY	CHANGE	PAGES AFFECTED

MATERIAL - SPECIAL 2024 T86 ALUMINUM -

MECHANICAL AND CORROSIVE PROPERTIES - DETERMINATION OF

PURPOSE:

To evaluate 2024-T86 aluminum alloy sheet material which is specially produced with cladding thicknesses of 2 1/2% of total thickness on both faces and 2 1/2% of total thickness on one face with 1 1/2% of total thickness on the opposite face..

SUMMARY:

The tensile properties of 2024-T86 aluminum alloy sheet material with cladding thicknesses of 2 1/2% of total thicknesses on both faces and 2 1/2% on one face and 1 1/2% of total thickness on the opposite face were determined for the "as received" condition and after dynamic etching to various thicknesses. The results show that the tensile properties of the .063 gage 2 1/2 - 2 1/2% clad sheet and the .051 gage 2 1/2 - 1 1/2% clad sheet material in the "as received" condition meet the requirements of specification QQ-A-362. The tensile properties of the .051 gage 2 1/2 - 2 1/2% sheet material did not meet specification requirements until after it had been resolution treated, restrain hardened and reaged. Variations in properties between sheets was only slight. The largest variation of approximately 6% was found in the .051 gage 2 1/2 - 2 1/2% clad sheet which required reconditioning.

The change in properties due to dynamic etching and salt spray tests are shown in Table III.

BACKGROUND:

At the time of this test the thinnest clad 2024-T86 sheet in widths beyond 60 inches was the .051 gage. This material was used by etching one side to obtain a thinner gage. The comparatively thick cladding of the .051 gage lowers the tensile strength below that obtainable from thinner cladding on the same gage. Normally, clad 2024-T86 sheet supplied to QQ-A-362 has 4% (of the composite) minimum cladding thickness per surface for gages less than .063 inch. For gages .063 inch and greater the cladding thickness per side is 2% minimum or approximately 2-1/2% nominal. Therefore, the standard gage .051 per QQ-A-362 has a cladding thickness of 1% minimum or approximately 5% nominal per side. The Aluminum Company of America furnished the various non-standard cladding thickness combinations used for these tests.

MATERIAL - SPECIAL 2024 T86 ALUMINUM -

MECHANICAL AND CORROSIVE PROPERTIES - DETERMINATION OF

OBJECT:

To determine the room temperature mechanical properties of .051 in. thick aluminum alloy 2024-T86 sheet material which has been clad on each side to 2 1/2% of the total thickness, and also that which has been clad to 2 1/2% on one side and 1 1/2% on the other. The properties were to be determined before and after dynamic etching on one surface only to various final sheet thicknesses. The mechanical properties of the 2 1/2 - 2 1/2% clad .051 in. sheet were also to be compared with those of .063 in. sheet with the same cladding thickness after running a salt spray test on both.

PROCEDURE:

All specimens were cut with the long dimensions of the specimen perpendicular to the long dimension of the grain. All sheets and specimens were stamped for retaining identity. Sheets were lettered A thru K. Standard tensile specimens were prepared and one specimen was tested from each sheet in the "as received" condition. All testing was done in either a 60,000 or a 5000 lb. Baldwin universal testing machine equipped with a MA-1 microformer recorder.

The .051 in. 2 1/2 - 2 1/2% clad and .051 in. 2 1/2 - 1 1/2% clad material were dynamically etched to thicknesses of .048, .040, .032, and .020 inches. The 2 1/2 - 1 1/2% clad sheets were etched on the 1 1/2% side only. Three transverse tensile specimens of each thickness were tested.

Salt spray tests*were run on the .051 and .063 in. 2 1/2 - 2 1/2% clad sheet material for 250 hours. Four tensile specimens of each material were tested.

When it was found that the .051 in. 2 1/2 - 2 1/2% clad had mechanical properties below specification requirements, three additional specimens of this material were resolution treated, strain hardened and aged to the T86 condition. These specimens were then tensile tested.

RESULTS:

Results are shown in Tables I, II, and III, and graphically in Figures 1, 2, 3, 4, and 5. Graphs show average values for each test condition.

*Salt spray tests used 20% solution and were conducted in accordance with Federal Test Method Standard 151.

DISCUSSION:

Ultimate strength, yield strength, percent elongation and the modulus of elasticity for each test condition are included in Tables I and II.

Table III shows the amount of change in properties after dynamic etching from .051 in. thickness to thicknesses of .020, .032, .040 and .048 in., and after salt spray testing for 250 hours.

Stress-strain curves for each test condition are shown in Figures 1, 2, 3, 4, and 5.

The .051 in. 2 1/2 - 2 1/2% clad had ultimate and yield strengths below minimum specified values. Values for this material after it was reheat treated are shown in Table II. The tensile properties were raised above specification requirements after reheat treatment.

CONCLUSIONS:

The results of this test consist of data for the mechanical properties at room temperatures of .051 and .063 in. 2024 T86 aluminum alloy sheet clad 2 1/2% on each side and 2 1/2% on one side with 1 1/2% on the other.

These data include properties for material unetched and dynamic etched to various thicknesses. Also included, are data on the tensile properties of .051 and .063 in. 2 1/2 - 2 1/2% clad material after 250 hours salt spray exposure tests.

CONVAIR—FORT WORTH
TABULATION SHEET

TABLE 1

SPEC. NO.	GAGE (in.)	WIDTH (in.)	AREA (in.²)	YIELD (LBS.)	STR. P.S.I	ULT. (LBS.)	T.S. PSI	e (%)	E (PSI/in.)		% CLAD
A-1	.0630	.4981	.03138	2165	69,200	2300	73,290	6.0	10.6	AS REQ'D	(2½ - 2½)
B-1	.0630	.4990	.03144	2185	69,500	2295	73,000	6.0	10.6		(2½ - 2½)
C-1	.0630	.4986	.03141	2175	69,100	2295	73,060	5.5	10.7		(2½ - 2½)
AVERAGE					69,270		73,120	5.8	10.6		
D-1	.0525	.5016	.02633	1755	66,700	1890	71,780	6.0	10.3		(2½ - 1½)
E-1	.0518	.5018	.02599	1750	67,500	1880	72,340	7.0	10.5		(2½ - 1½)
F-1	.0524	.4960	.02599	1750	67,500	1880	72,340	7.0	10.5		(2½ - 1½)
G-1	.0525	.5015	.02632	1760	67,000	1895	72,000	6.0	10.4		(2½ - 1½)
AVERAGE					67,120		72,040	6.5	10.4		
H-1	.0550	.4998	.02749	1620	58,900	1795	65,300	7.0	10.5		(2½ - 2½)
I-1	.0550	.4990	.02744	1595	58,200	1775	64,690	7.5	10.4		(2½ - 2½)
J-1	.0549	.4958	.02722	1500	55,000	1705	62,640	6.5	10.4		(2½ - 2½)
K-1	.0549	.5010	.02750	1650	60,000	1810	65,820	6.0	10.3		(2½ - 2½)
AVERAGE					57,775		64,612	6.5	10.4		
J-2	.0235	.4990	.01173	640	54,500	723	61,600	5.0	10.0	".020"	(2½ - 2½)
J-3	.0234	.4998	.01170	630	53,900	700	59,900	5.0	10.0		"
J-4	.0238	.5005	.01191	640	53,600	724	60,600	6.0	9.8		"
AVERAGE					54,000		60,700	5.3	9.9		
J-5	.0341	.5007	.01707	940	55,100	1065	62,400	5.5	10.4	".032"	(2½ - 2½)
J-6	.0341	.5019	.01711	938	54,800	1085	63,400	6.0	10.1		"
J-7	.0340	.5010	.01703	950	55,800	1065	62,500	6.0	10.1		"
AVERAGE					55,233		62,767	5.8	10.2		
H-2	.0415	.4980	.02067	1225	59,200	1350	65,300	6.0	10.3	.040	(2½ - 2½)
H-3	.0413	.4946	.02043	1220	59,600	1335	65,200	6.0	10.2		"
H-4	.0417	.5024	.02095	1245	59,400	1385	66,200	5.5	10.2		"
AVERAGE					59,400		65,567	5.8	10.2		
H-5	.0480	.5179	.02486	1460	58,800	1625	65,300	7.0	10.6	.048"	(2½ - 2½)
H-6	.0480	.5190	.02471	1480	59,900	1635	65,500	6.0	10.5		"
H-7	.0480	.5170	.02482	1475	59,400	1625	65,500	7.0	10.4		"
AVERAGE					59,367		65,433	6.7	10.5		

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CONVAIR—FORT WORTH

TABULATION SHEET

TABLE 2

SPEC. NO.	GAGE (INS.)	WIDTH (INS.)	AREA (INS²)	YIELD (LBS.)	STR. PSI	P.L. (LBS.)	P.L. PSI	ELONG. (%)	R/T		% CLAD
G-2	.0240	.4966	.01192	770	64,600	830	69,600	4.5	4.8	.020	(2½-1½)
G-3	.0234	.5024	.01176	762	64,800	820	69,700	4.5	10.1	↓	"
G-4	.0230	.4904	.01128	728	64,600	772	68,500	4.0	10.2	↓	"
G-5	.0326	.4909	.01600	1085	66,200	1155	72,200	4.5	10.4	.032"	(2½-1½)
G-6	.0325	.5032	.01635	1090	66,700	1180	72,200	5.0	10.4	↓	"
G-7	.0326	.4909	.01600	1085	66,200	1155	72,200	4.5	10.3	↓	"
F-5	.0395	.4842	.01913	1300	67,900	1390	72,600	5.0	10.4	.040"	(2½-1½)
F-6	.0392	.5035	.01974	1320	66,800	1420	72,000	5.0	10.4	↓	"
F-7	.0392	.4992	.01957	1335	68,200	1435	73,400	5.0	10.2	↓	"
F-2	.0499	.5043	.02515	1705	67,770	1820	72,500	5.0	10.6	.048"	(2½-1½)
F-3	.0498	.5039	.02505	1700	67,860	1825	72,900	5.0	10.5	↓	"
F-4	.0498	.5017	.02493	1700	68,050	1810	72,450	6.0	10.4	↓	"
B-2	.0628	.5140	.03228	2185	67,700	2340	72,500	6.0	10.7	.060"	(2½-1½)
B-3	.0628	.5135	.03220	2190	68,000	2340	72,670	5.0	10.7	↓	"
C-2	.0630	.5147	.03243	2185	67,400	2335	72,000	5.0	10.7	↓	"
C-3	.0629	.5135	.03230	2185	67,600	2340	72,440	6.0	10.9	↓	"
I-2	.0550	.5163	.02840	1635	57,500	1815	63,900	6.0	10.4	↓	"
I-3	.0550	.5165	.02840	1640	57,700	1835	64,600	6.0	10.5	↓	"
I-4	.0550	.5162	.02837	1650	58,100	1825	64,300	6.0	10.4	↓	"
I-5	.0550	.5154	.02835	1635	57,700	1815	64,000	6.0	10.4	↓	"
H-8	.0535	.5129	.02744	1970	71,800	2035	74,200	4.0	9.9		
J-?	.0530	.5134	.02721	1835	67,400	1920	70,600	4.0	9.9		
K-9	.0528	.5135	.02711	1855	68,400	1925	71,000	4.0	9.9		

NOTE—SPECIMENS H-8, J-8, K-9 WERE RE-HEAT TREATED AND COLD WORKED TO THE T86 CONDITION

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TABLE 3

% CLAD	INITIAL GAGE (IN.)	FINAL GAGE (IN.)	DECREASE IN ULT. T.S. (%)	DECREASE IN YIELD (%)	DECREASE IN ELONG. (%)	DECREASE IN (%)
2½ - 2½	.051	.020	3.8	6.9	1.5	5.0
		.032	NONE	4.8	1.0	2.0
		.040	NONE	NONE	1.0	2.0
		.043	NONE	NONE	NONE	NONE
2½ - 1½	.051	.020	4.0	3.2	2.5	4.7
		.032	NONE	1.2	2.0	NONE
		.040	NONE	NONE	1.5	NONE
		.042	NONE	NONE	1.5	NONE
	SALT SPRAY TESTED					
	.051		NONE	0.5	NONE	NONE
	.063		1.0	2.3	NONE	NONE

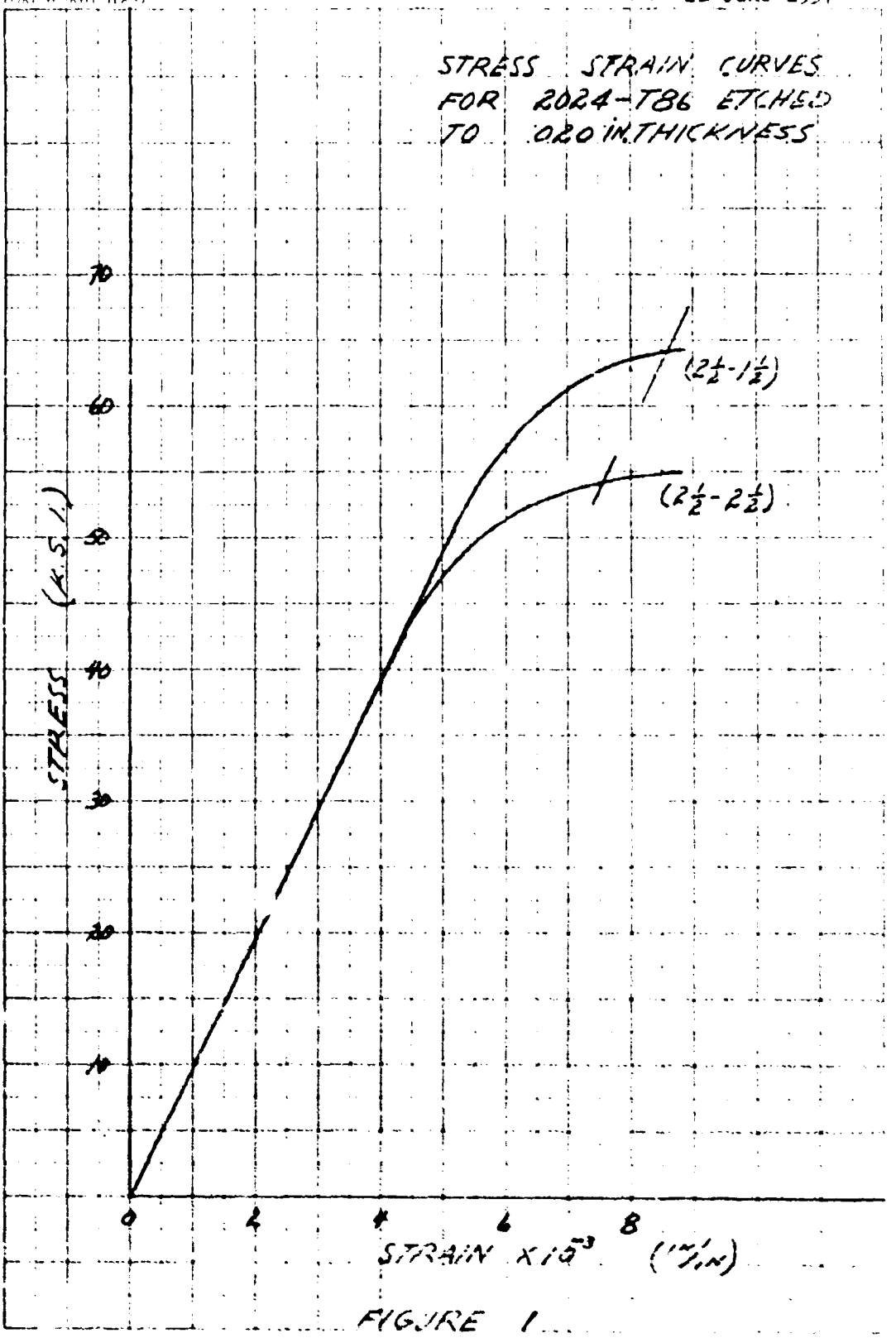
STRESS STRAIN CURVES
FOR 2024-T86 ETCHED
TO .020 IN. THICKNESS
(2½-1½)
(2½-2½)
STRESS (K.S.I.)
70
60
50
40
30
20
10
0
2
4
6
8
STRAIN X10⁻³ (IN/IN)

FIGURE 1

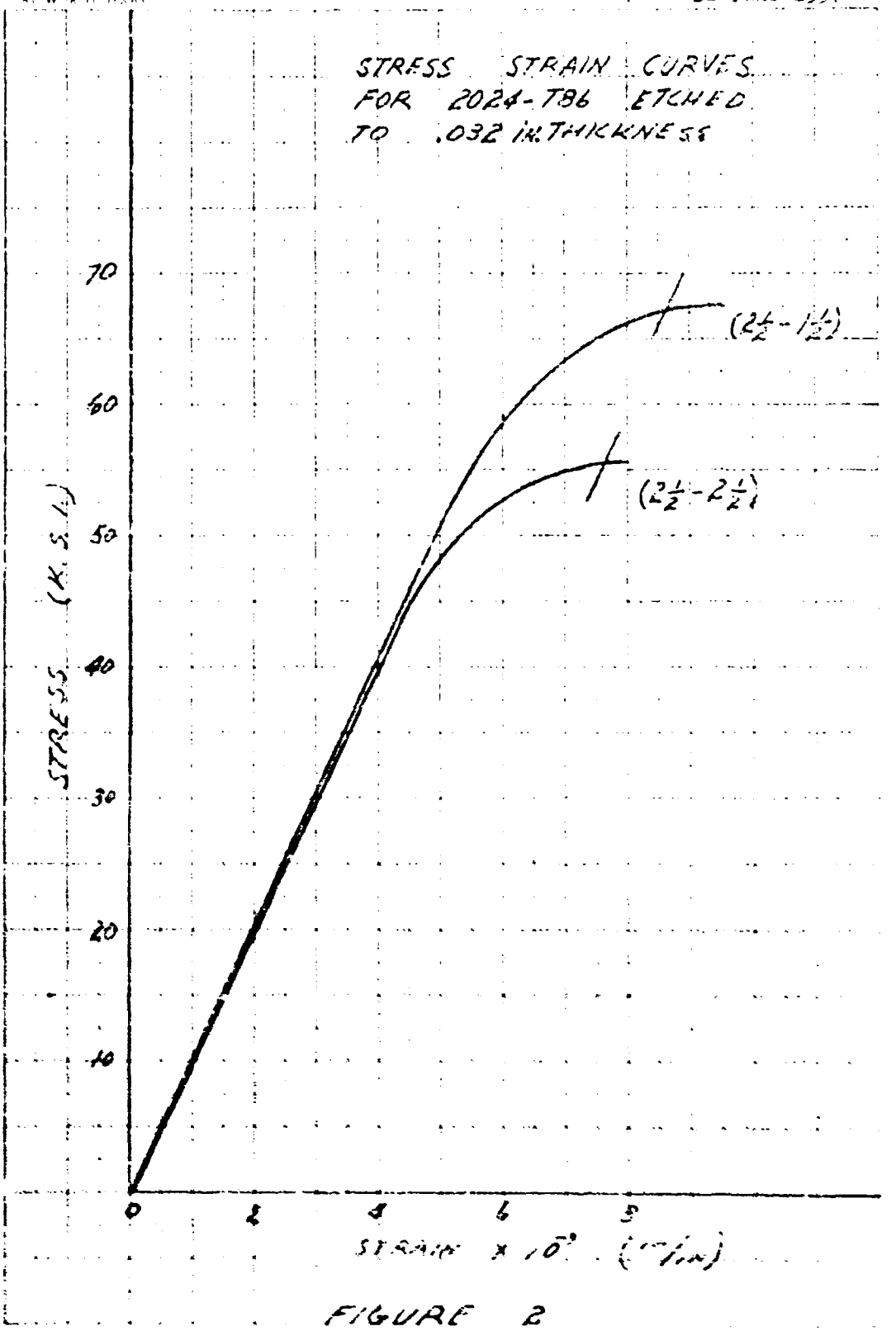
STRESS STRAIN CURVES
FOR 2024-T86 ETCHED
TO .032 IN. THICKNESS
70
60
50
40
30
20
10
STRESS (K.S.I.)
$(2\frac{1}{2}-1\frac{1}{2})$
$(2\frac{1}{2}-2\frac{1}{2})$
0
2
4
6
8
STRAIN x 10^3 $(\frac{in}{in})$

FIGURE 2

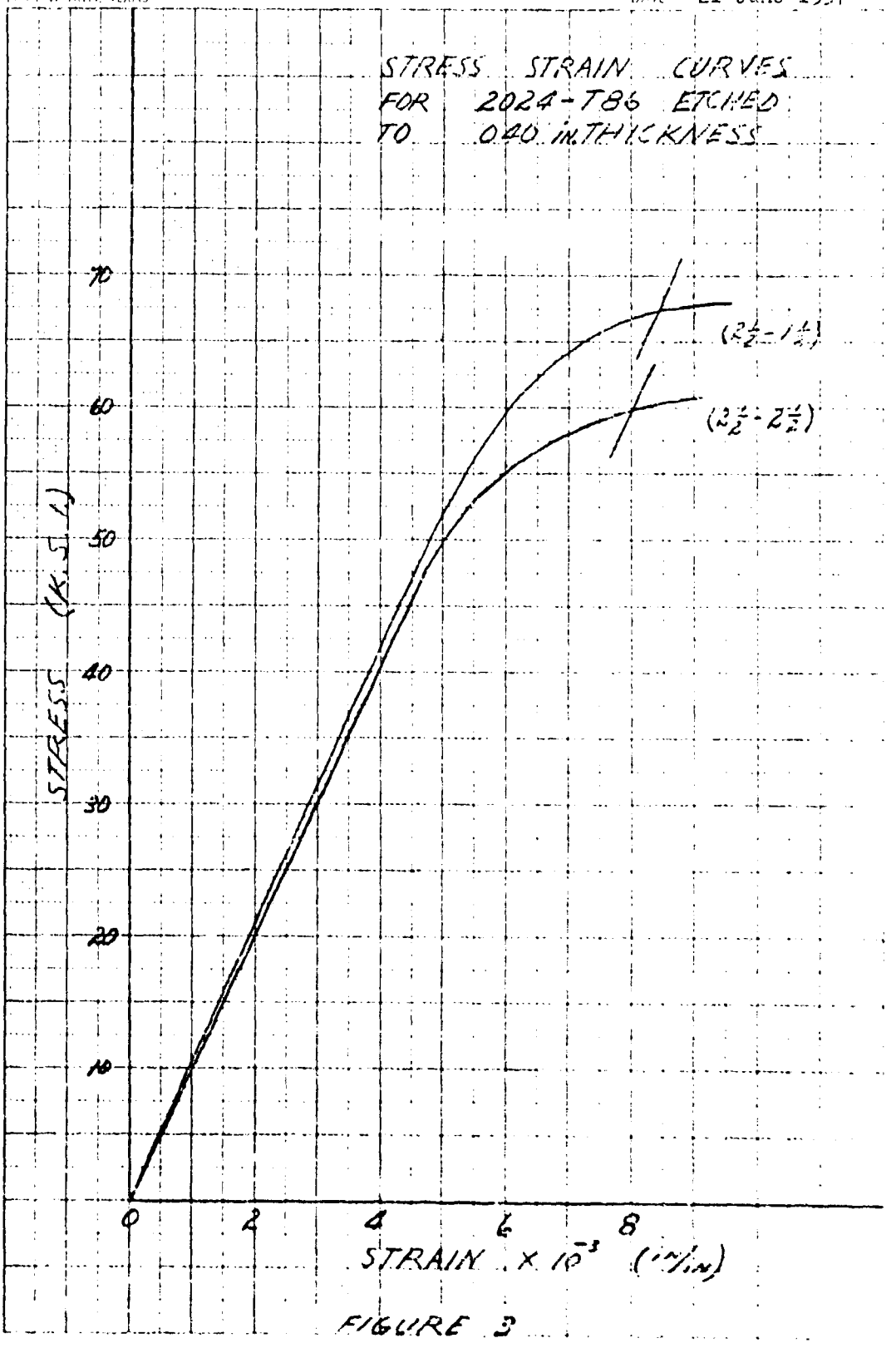
STRESS STRAIN CURVES
FOR 2024-T86 ETCHED
TO .040 IN. THICKNESS
(2½-1½)
(2½-2½)
STRESS (K.S.I.)
70
60
50
40
30
20
10
0
2
4
6
8
STRAIN . X 10⁻³ (IN/IN)

FIGURE 3

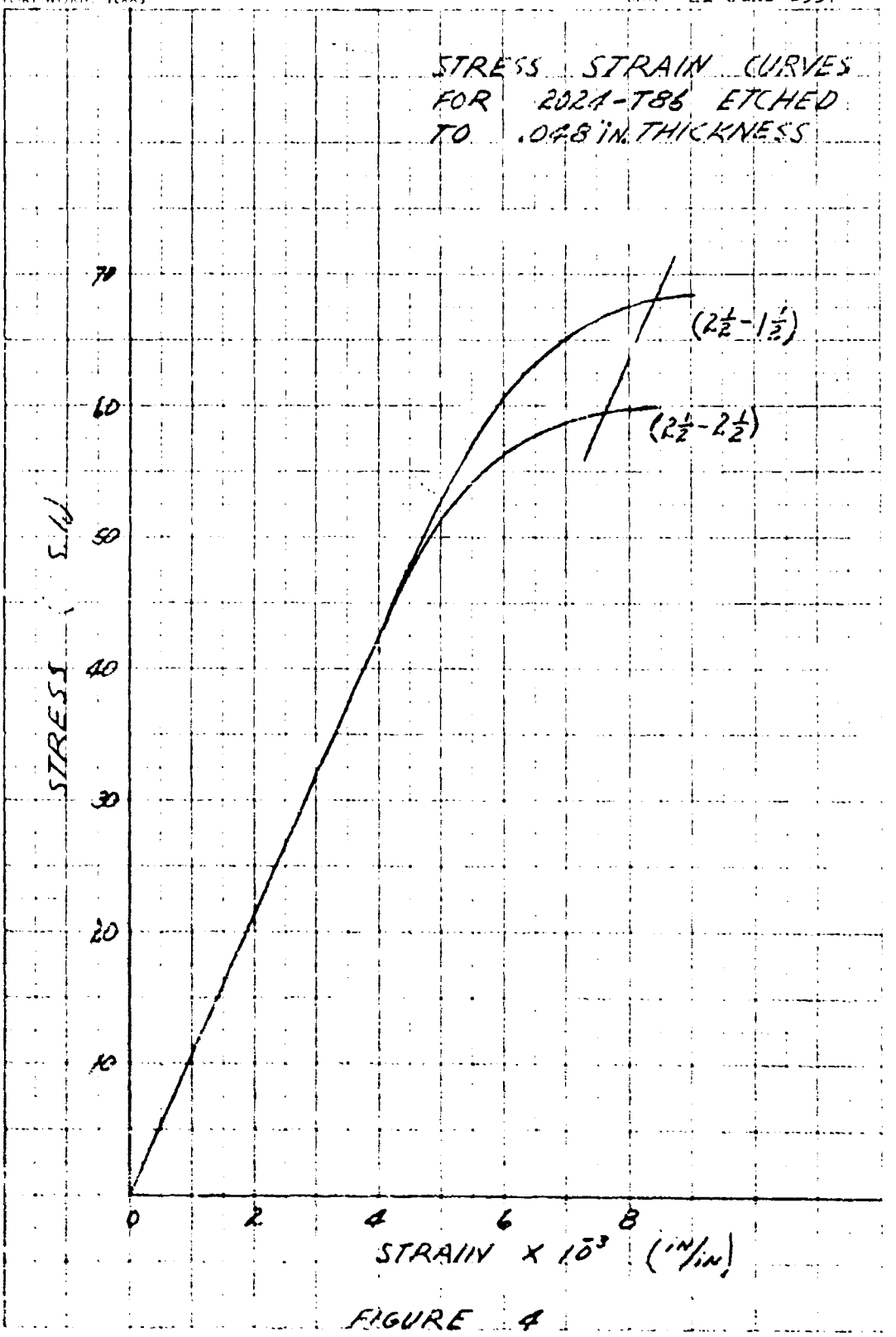
STRESS STRAIN CURVES FOR 2024-T86 ETCHED TO .048 IN. THICKNESS
(2½-1½)
(2½-2½)
70
60
50
40
30
20
10
STRESS KSI
0
2
4
6
8
STRAIN X 10⁻³ (IN/IN)

FIGURE 4

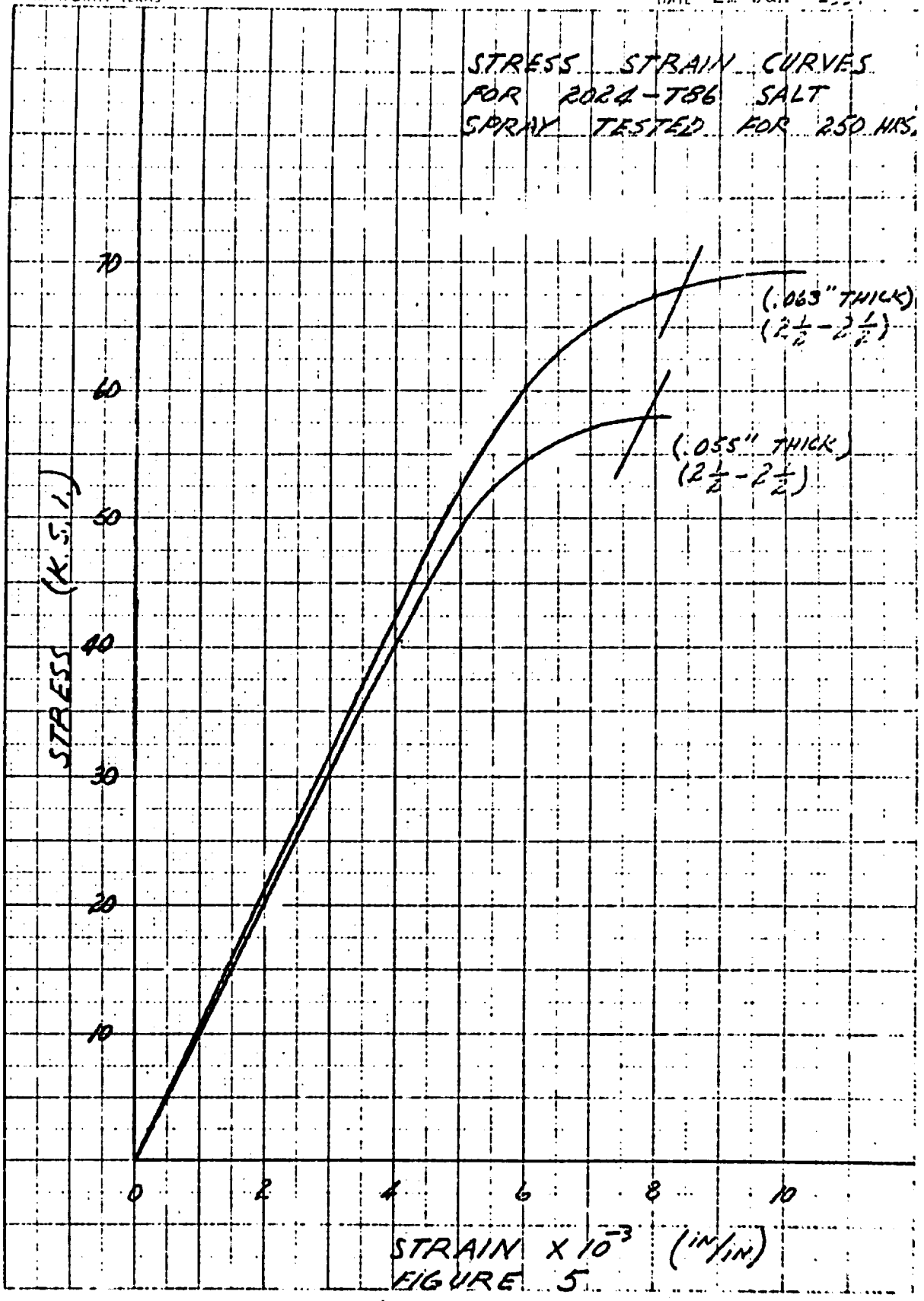
STRESS STRAIN CURVES
FOR 2024-T86 SALT
SPRAY TESTED FOR 250 HRS.
(.063" THICK)
(2½-2½)
(.055" THICK)
(2½-2½)
STRESS (K.S.I.)
70
60
50
40
30
20
10
0
2
4
6
8
10
STRAIN X 10⁻³ (IN/IN)

FIGURE 5